Is there np pairing in N=Z Nuclei?

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There are many experimental observables (signatures) supporting the existence of a condensate of nn and pp pairs, but few have been discussed for the case of an np pair condensate. In this work [1] we present an analysis of experimental binding energies of N=Z nuclei and the relative excitation energies of the lowest T=0 and T=1 states in self-conjugate (N=Z, T_z=0) odd-odd nuclei. The binding energy difference is used as a measure of the pair gap. We conclude there is no evidence for a T=0 np pairing condensate.

Figure 1 shows, as a function of mass, the difference in binding energies between the T=0 ground state in an even-even N=Z nucleus and (i) the lowest T=0 state in an odd-odd N=Z nucleus (circles), or (ii) the lowest T=1 state in an odd-odd N=Z nucleus (squares). For T=1 states we have subtracted the average symmetry energy contribution to the binding energy, $E_{sym}^{T=1} = 150/A$ (MeV), in order to isolate the collective pairing contribution. There is no correction for T=0 states. The solid line shows the adopted smooth dependence of Δ on A ($2\Delta \sim 24/A^{1/2}$ MeV) used to describe the nn and pp T=1 pair gap in N>Z nuclei.

The T=0 binding energy difference is large and follows the average $2\Delta \sim 24/A^{1/2}$ MeV dependence observed throughout the nuclear chart. The lowest $T = 0$ states in odd-odd N=Z nuclei then behave like those in any other odd-odd nucleus where the extra n and p block the $T = 1$ pairing to the same degree as any “standard” 2-quasiparticle state. In contrast, the T=1 binding energy difference is close to zero, after correcting for the symmetry energy. Correcting for the symmetry term (in a manner similar to the volume or Coulomb terms) will not remove the collective pair correlations which we are looking for.

The data in figure 1 can be understood if we assume full (nn, pp, and np) T=1 collective pairing and no (or very little) T=0 collective pairing. If there were a significant T=0 condensate then the T=0 binding energy difference would be smaller than the gap given by $2\Delta \sim 24/A^{1/2}$ MeV, which represents a maximum value. In fact, for a pair condensate comprising an equal amount of T=0 and T=1 pairs (SU(4) limit) the observed T=0 and T=1 gaps would be equal and $\sim$0.

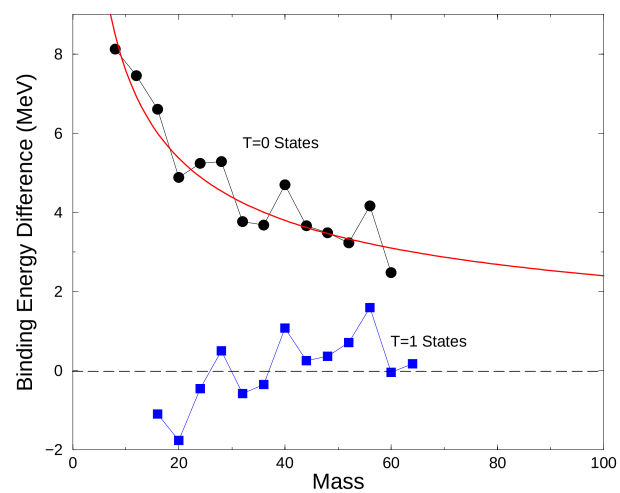

Figure 1: *Binding energy differences, as a function of A, between the T=0 ground state in an even-even N=Z nucleus and (i) the lowest T=0 state in an odd-odd N=Z nucleus (circles), or (ii) the lowest T=1 state in an odd-odd N=Z nucleus (squares), after subtracting an average symmetry energy contribution ($E_{sym} = 150/A$ MeV). The solid line is $2\Delta \sim 24/A^{1/2}$ MeV.*

[1] A.O.Macchiavelli et al., Phys. Rev. C (in press).